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JEST Physics Sample Paper 2027

Joint Entrance Screening Test (JEST) 2027 · Physics · Practice Paper

Questions	Marks	Time	Negative marking
40 (10 + 20 + 10)	**100**	**3 hours (180 minutes)**	**–1/3 in Part A, –1 in Part B**

Part	Section	Questions	Q. No.
Part A	Part A: 1-mark MCQs (+1, –1/3)	10	1 to 10
Part B	Part B: 3-mark MCQs (+3, –1)	20	11 to 30
Part C	Part C: 3-mark numerical questions (+3, no negative)	10	31 to 40

Instructions

1. This paper has 40 questions in three parts, as in the JEST 2026 Physics paper.
2. Part A (Q1–10): multiple-choice questions with four options, only one correct. +1 mark for a correct answer, –1/3 mark for a wrong answer.
3. Part B (Q11–30): multiple-choice questions with four options, only one correct. +3 marks for a correct answer, –1 mark for a wrong answer.
4. Part C (Q31–40): numerical-answer questions. Enter the answer as a number (round to the nearest integer where asked). +3 marks for a correct answer; no negative marking.
5. Unanswered questions get 0 marks. Maximum marks 100. Time 3 hours.
6. Calculators, mobile phones and other electronic devices are not allowed. The real test is computer-based; here, write your answer in the box under each Part C question.
7. The answer key and short solutions are at the end. Check them only after you finish.

This is an AglaSem practice paper written on the official JEST 2026 Physics pattern (jest.org.in FAQ and official sample question paper: Part A 10 MCQs, Part B 20 MCQs, Part C 10 numerical questions; 100 marks; 180 minutes) and the official JEST Physics syllabus. It is not an official JEST paper, and its questions are original. JEST 2027 rules are not yet announced.

Part A

Part A: 1-mark MCQs (+1, –1/3)

1. A particle moves in the attractive potential V(r) = –k/r. Besides the energy and the angular momentum, which of the following is a conserved vector?

(A) The radial unit vector r̂ (B) The Laplace–Runge–Lenz vector

(C) The force vector F (D) The linear momentum p

2. With σ_x, σ_Y, σ_z the Pauli matrices, the product $\sigma_x\sigma_Y$ equals

(A) σ_z (B) iσ_z

(C) the 2 × 2 identity (D) –iσ_z

3. For an ideal Fermi gas of spin-1/2 particles in three dimensions at T = 0, the mean energy per particle in terms of the Fermi energy E_F is

(A) (3/2)E_F (B) (2/3)E_F

(C) (3/5)E_F (D) (1/2)E_F

4. An ideal op-amp is used as an inverting amplifier with input resistor 2 kΩ and feedback resistor 10 kΩ. Its voltage gain is

(A) +6 (B) –6

(C) +5 (D) –5

5. The Boolean expression $A + \bar{A}B$ simplifies to

(A) $A + B$ (B) A

(C) AB (D) $\bar{A} + B$

6. If H is a Hermitian matrix, then the matrix $U = \exp(iH)$ is always

(A) unitary (B) real and symmetric

(C) Hermitian (D) nilpotent

7. Unpolarised light falls from air on a flat glass surface of refractive index $\sqrt{3}$. The reflected light is completely plane polarised when the angle of incidence is

(A) 54.7° (B) 30°

(C) 60° (D) 45°

8. Black-body radiation in thermal equilibrium inside a two-dimensional cavity (photons confined to a plane) has an energy per unit area proportional to

(A) T^(5/2) (B) T^2

(C) T^4 (D) T^3

9. In the non-relativistic hydrogen atom, including the electron spin, the number of distinct states with principal quantum number $n = 3$ is

(A) 9 (B) 12

(C) 18 (D) 6

10. The number of conjugacy classes of the symmetric group S_3 (the permutation group of three objects) is

(A) 6 (B) 2

(C) 3 (D) 4

Part B

Part B: 3-mark MCQs (+3, –1)

11. A particle of mass m moves in one dimension in the potential $V(x) = V_0(x^2/a^2 - 1)^2$, with $V_0 > 0$. The angular frequency of small oscillations about either minimum is

(A) $\sqrt{(4V_0/(ma^2))}$ (B) $\sqrt{(16V_0/(ma^2))}$

(C) $\sqrt{(2V_0/(ma^2))}$ (D) $\sqrt{(8V_0/(ma^2))}$

12. A planet moves in an elliptical orbit of eccentricity 1/2 about the Sun. The ratio of its maximum speed to its minimum speed is

(A) 2 (B) $\sqrt{3}$

(C) 9 (D) 3

13. A particle of rest mass m moving with speed 0.6c collides with an identical particle at rest, and the two stick together. The rest mass of the composite particle is

(A) 2m (B) $(3/\sqrt{2})m$

(C) $\sqrt{5}$ m (D) $(9/4)m$

14. Two identical masses m on a frictionless horizontal line are each joined to a fixed wall by a spring of constant k (one wall on each side) and to each other by a spring of the same constant k. The normal-mode angular frequencies are

(A) $\sqrt{(k/m)}$ and $\sqrt{(3k/m)}$ (B) $\sqrt{(2k/m)}$ and $\sqrt{(3k/m)}$

(C) $\sqrt{(k/2m)}$ and $\sqrt{(3k/m)}$ (D) $\sqrt{(k/m)}$ and $\sqrt{(2k/m)}$

15. A point charge q is placed at distance d from the centre of a grounded conducting sphere of radius R (d > R). The magnitude of the force on the charge is

(A) $q^2R^2 / [4\pi\varepsilon_0(d^2 - R^2)^2]$ (B) $q^2 / [16\pi\varepsilon_0(d - R)^2]$

(C) $q^2Rd / [4\pi\varepsilon_0(d^2 - R^2)^2]$ (D) $q^2R / [4\pi\varepsilon_0\, d(d - R)^2]$

16. Charges +q at (a, 0, 0), +q at (–a, 0, 0) and –2q at the origin form a static distribution. At a distance $r \gg a$, the electrostatic potential falls off as

(A) $1/r^2$ (B) $1/r^3$

(C) $1/r^4$ (D) $1/r$

17. A steady current I flows in a square loop of side a. The magnitude of the magnetic field at the centre of the square is

(A) $\sqrt{2}\,\mu_0 I/(\pi a)$ (B) $2\sqrt{2}\,\mu_0 I/(\pi a)$

(C) $\mu_0 I/(2a)$ (D) $2\mu_0 I/(\pi a)$

18. A parallel-plate capacitor with circular plates of radius R is being charged by a steady current I. Neglecting edge effects, the magnitude of the magnetic field between the plates at a distance $r < R$ from the axis is

(A) $\mu_0 I r^2/(2\pi R^3)$ (B) zero

(C) $\mu_0 I/(2\pi r)$ (D) $\mu_0 I r/(2\pi R^2)$

19. A particle is in the ground state of an infinite square well with walls at x = 0 and x = L. The wall at x = L is suddenly moved to x = 2L. The probability that the particle is found in the ground state of the new well is

(A) $8/(3\pi^2)$ (B) $16/(9\pi^2)$

(C) 1/2 (D) $32/(9\pi^2)$

20. A spin-1/2 particle is in the eigenstate of S_z with eigenvalue $+\hbar/2$. The spin component is measured along a unit vector in the x–z plane making an angle of 60° with the z-axis. The probability of obtaining $+\hbar/2$ is

(A) 3/4 (B) 1/4

(C) 1/2 (D) $\sqrt{3}/2$

21. Two spin-1 particles are in the state $|m_1 = 1\rangle|m_2 = -1\rangle$. The probability that a measurement of the total spin gives S = 0 is

(A) 1/3 (B) 2/3

(C) 1/6 (D) 1/2

22. A one-dimensional harmonic oscillator (mass m, angular frequency ω) is perturbed by $H' = \lambda x$. The second-order correction to the ground-state energy is

(A) $-\lambda^2/(2m\omega^2)$ (B) $-\lambda^2/(m\omega^2)$

(C) 0 (D) $+\lambda^2/(2m\omega^2)$

23. The trial wave function $\psi(x) = e^{\wedge}(-\alpha|x|)$ ($\alpha > 0$) is used in the variational method for a one-dimensional harmonic oscillator of frequency ω. The best upper bound obtained for the ground-state energy is

(A) $\hbar\omega/\sqrt{2}$ (B) $3\hbar\omega/4$

(C) $\hbar\omega/2$ (D) $\hbar\omega$

24. N non-interacting spin-1/2 particles, each with magnetic moment μ, are in a magnetic field B at temperature T. The mean magnetisation (moment along B) is

(A) $N\mu \coth(\mu B/kT)$ (B) $N\mu^2 B/(3kT)$

(C) $N\mu \tanh(\mu B/kT)$ (D) $N\mu[\coth(\mu B/kT) - kT/(\mu B)]$

25. For n moles of a van der Waals gas, $(P + an^2/V^2)(V - nb) = nRT$, the quantity $(\partial U/\partial V)_T$ equals

(A) $nRT/(V - nb)$ (B) an^2/V^2

(C) 0 (D) $-an^2/V^2$

26. Black-body radiation in a cavity is expanded reversibly and adiabatically until its volume becomes 8 times the initial volume. If the initial temperature is T, the final temperature is

(A) T/4 (B) T/2

(C) T/8 (D) $T/(2\sqrt{2})$

27. A series LCR circuit has R = 10 Ω, L = 10 mH and C = 1 μF. Its resonant angular frequency ω_0 and quality factor Q are

(A) $\omega_0 = 10^4$ rad/s, Q = 100 (B) $\omega_0 = 10^3$ rad/s, Q = 10

(C) $\omega_0 = 10^5$ rad/s, Q = 1 (D) $\omega_0 = 10^4$ rad/s, Q = 10

28. In 8-bit two's complement representation, the number −45 is written as

(A) 10101101 (B) 11010011

(C) 01010011 (D) 11010010

29. The value of the integral $\int_{-\infty}^{\infty} dx/(x^2 + 1)^2$ is

(A) π/4 (B) π

(C) π/2 (D) 2π

30. The eigenvalues of the matrix [[2, 1, 0], [1, 2, 1], [0, 1, 2]] are

(A) 2 and $2 \pm \sqrt{2}$ (B) 1, 2 and 3

(C) 0 and $2 \pm \sqrt{3}$ (D) 2 and $2 \pm \sqrt{3}$

Part C

Part C: 3-mark numerical questions (+3, no negative)

31. A sample of hydrogen atoms is excited so that all of them are in the n = 6 level. As they return to the ground state by all possible routes, how many distinct spectral lines can be emitted?

32. A ball is dropped from a height of 30 m onto a hard floor. The coefficient of restitution is 1/2. Neglecting air resistance, find the total distance (in m) travelled by the ball before it comes to rest.

33. A particle has rest energy 3 GeV and total energy 5 GeV. What is its momentum in GeV/c?

34. A Carnot refrigerator keeps its cold chamber at −23 °C while rejecting heat to a room at 27 °C. What is its coefficient of performance?

35. Evaluate $(1/(\pi i)) \oint_C (z^2 + 1)/(z(z - 1))\, dz$, where C is the circle $|z| = 2$ traversed anticlockwise.

36. Let J be the 5×5 matrix with every entry equal to 1, and I the 5×5 identity matrix. Find $\det(J + 2I)$.

37. For a three-dimensional isotropic harmonic oscillator of angular frequency ω, find the degeneracy of the energy level $E = (9/2)\hbar\omega$.

38. Five non-interacting electrons (spin 1/2) are placed in a one-dimensional infinite square well. If E_1 is the lowest single-particle energy, find the ground-state energy of the system in units of E_1.

39. An ideal op-amp summing amplifier (inverting) has a feedback resistor of 20 kΩ. Input $V_1 = 1$ V is applied through 10 kΩ and input $V_2 = 0.5$ V through 5 kΩ. Find the output voltage in volts.

40. Light of wavelength 600 nm falls normally on a diffraction grating with 5000 lines per cm. What is the highest order of the principal maximum that can be observed?

Answer Key

1	**B**	2	**B**	3	**C**	4	**D**	5	**A**	6	**A**	7	**C**	8	**D**	9	**C**	10	**C**
11	**D**	12	**D**	13	**B**	14	**A**	15	**C**	16	**B**	17	**B**	18	**D**	19	**D**	20	**A**
21	**A**	22	**A**	23	**A**	24	**C**	25	**B**	26	**B**	27	**D**	28	**B**	29	**C**	30	**A**
31	**15**	32	**50**	33	**4**	34	**5**	35	**2**	36	**112**	37	**10**	38	**19**	39	**–4**	40	**3**

Solutions

Part A: 1-mark MCQs (+1, –1/3)

1. (B) For the Kepler (1/r) potential the Laplace–Runge–Lenz vector $\mathbf{A} = \mathbf{p} \times \mathbf{L} - mk\,\hat{\mathbf{r}}$ is conserved; it points along the major axis and is why bound orbits are closed. Linear momentum is not conserved because there is a force.

2. (B) $\sigma_x\sigma_y$ = [[0, 1], [1, 0]][[0, –i], [i, 0]] = [[i, 0], [0, –i]] = $i\sigma_z$ (generally $\sigma_j\sigma_k = \delta_{jk}I + i\varepsilon_{jkl}\sigma_l$).

3. (C) The density of states in 3D is $g(E) \propto \sqrt{E}$, so ⟨E⟩ = ∫$_0$^(E_F) E^(3/2) dE / ∫$_0$^(E_F) E^(1/2) dE = (2/5)E_F^(5/2) / ((2/3)E_F^(3/2)) = (3/5)E_F.

4. (D) For an inverting amplifier, $A = -R_f/R_{in} = -10/2 = -5$. (+6 would be the gain of the non-inverting configuration, 1 + R_f/R_in.)

5. (A) $A + \bar{A}B = (A + \bar{A})(A + B) = A + B$, using the distributive law $X + YZ = (X + Y)(X + Z)$.

6. (A) $U^\dagger = \exp(-iH^\dagger) = \exp(-iH)$, and since H commutes with itself, $U^\dagger U = \exp(-iH)\exp(iH) = I$. So U is unitary (its eigenvalues e^(iλ) lie on the unit circle).

7. (C) At Brewster's angle $\tan\theta_B = n_2/n_1 = \sqrt{3}$, so $\theta_B = 60°$. At this angle the reflected and refracted rays are perpendicular.

8. (D) In d dimensions the density of photon modes per unit frequency goes as ω^(d–1), so the energy density is ∫ ω^(d–1) · ħω/(e^(ħω/kT) – 1) dω ∝ T^(d+1). For d = 2 this is T^3 (and T^4 for d = 3).

9. (C) For given n, l = 0, …, n – 1 and m = –l, …, l give $n^2 = 9$ orbital states; the two spin states double this to $2n^2 = 18$.

10. (C) Conjugacy classes in S_n correspond to cycle types. For S_3: the identity, the three transpositions, and the two 3-cycles, so 3 classes (matching three irreducible representations).

Part B: 3-mark MCQs (+3, –1)

11. (D) The minima are at $x = \pm a$. $V'(x) = (4V_0x/a^2)(x^2/a^2 - 1)$, so $V''(x) = (4V_0/a^2)(x^2/a^2 - 1) + 8V_0x^2/a^4$, and $V''(a) = 0 + 8V_0/a^2 = 8V_0/a^2$. Then $\omega = \sqrt{(V''(a)/m)} = \sqrt{(8V_0/(ma^2))}$.

12. (D) Angular momentum conservation gives $r_p v_p = r_a v_a$, so $v_{max}/v_{min} = r_a/r_p = a(1 + e)/(a(1 - e)) = (1.5)/(0.5) = 3$.

13. (B) $\gamma = 1.25$. Total energy $E = (1.25 + 1)mc^2 = 2.25mc^2$, momentum $p = 1.25 \times 0.6\ mc = 0.75mc$. $M^2c^4 = E^2 - p^2c^2 = (5.0625 - 0.5625)m^2c^4 = 4.5\ m^2c^4$, so $M = \sqrt{4.5}\ m = (3/\sqrt{2})m \approx 2.12m$ (more than 2m because kinetic energy becomes rest energy).

14. (A) Equations: $m\ddot{x}_1 = -kx_1 - k(x_1 - x_2)$, $m\ddot{x}_2 = -kx_2 - k(x_2 - x_1)$. The in-phase mode ($x_1 = x_2$) does not stretch the middle spring: $\omega^2 = k/m$. The out-of-phase mode ($x_1 = -x_2$) has $\omega^2 = (k + 2k)/m = 3k/m$.

15. (C) The image charge is $q' = -qR/d$ at distance R^2/d from the centre. The separation is $d - R^2/d = (d^2 - R^2)/d$, so $F = q \cdot qR/d\ /\ [4\pi\varepsilon_0((d^2 - R^2)/d)^2] = q^2Rd/[4\pi\varepsilon_0(d^2 - R^2)^2]$, attractive.

16. (B) The total charge is 0 (no monopole term) and the dipole moment $\Sigma q_i r_i = qa\,\hat{x} - qa\,\hat{x} + 0 = 0$. The first non-zero term is the quadrupole term, which goes as $1/r^3$.

17. (B) Each side is at distance a/2 from the centre and subtends ±45°: $B_{side} = [\mu_0 I/(4\pi(a/2))](\sin 45° + \sin 45°) = \sqrt{2}\,\mu_0 I/(2\pi a)$. Four sides add: $B = 4 \times \sqrt{2}\,\mu_0 I/(2\pi a) = 2\sqrt{2}\,\mu_0 I/(\pi a)$.

18. (D) The displacement current $I_d = I$ is spread uniformly over the plate area, so the current enclosed by a circle of radius r is $I\,r^2/R^2$. Ampère–Maxwell: $B \cdot 2\pi r = \mu_0\, I\, r^2/R^2$, giving $B = \mu_0 Ir/(2\pi R^2)$.

19. (D) Sudden approximation: the wave function is unchanged. Overlap $c = \int_0^L \sqrt{(2/L)}\sin(\pi x/L)\cdot\sqrt{(1/L)}\sin(\pi x/2L)\,dx = (\sqrt{2}/L)\times 4L/(3\pi) = 4\sqrt{2}/(3\pi)$. Probability $|c|^2 = 32/(9\pi^2) \approx 0.36$.

20. (A) The $+\hbar/2$ eigenstate along $\hat{n}(\theta, \phi = 0)$ is $\cos(\theta/2)|\uparrow\rangle + \sin(\theta/2)|\downarrow\rangle$. The probability is $|\langle\hat{n}+|\uparrow\rangle|^2 = \cos^2(\theta/2) = \cos^2 30° = 3/4$.

21. (A) The singlet is $|0, 0\rangle = (1/\sqrt{3})(|1, -1\rangle - |0, 0\rangle + |-1, 1\rangle)$, so the Clebsch–Gordan coefficient $\langle 1, 1; 1, -1|0, 0\rangle = 1/\sqrt{3}$ and the probability is 1/3.

22. (A) Only $\langle 1|x|0\rangle = \sqrt{(\hbar/2m\omega)}$ is non-zero, so $E^{(2)} = -\lambda^2(\hbar/2m\omega)/(\hbar\omega) = -\lambda^2/(2m\omega^2)$. This is exact: completing the square, $V = (1/2)m\omega^2(x + \lambda/m\omega^2)^2 - \lambda^2/(2m\omega^2)$. The first-order shift is zero.

23. (A) With the normalised state, $\langle T\rangle = \hbar^2\alpha^2/(2m)$ and $\langle x^2\rangle = 1/(2\alpha^2)$, so $E(\alpha) = \hbar^2\alpha^2/(2m) + m\omega^2/(4\alpha^2)$. Minimising (AM–GM): $E_{min} = 2\sqrt{(\hbar^2\omega^2/8)} = \hbar\omega/\sqrt{2} \approx 0.707\hbar\omega$, above the exact $\hbar\omega/2$ as it must be.

24. (C) Each moment has energies $\mp\mu B$, so $Z_1 = 2\cosh(\mu B/kT)$ and $\langle\mu_z\rangle = \mu(e^{(x)} - e^{(-x)})/(e^{(x)} + e^{(-x)}) = \mu \tanh x$ with $x = \mu B/kT$. The Langevin form (last option) is for classical dipoles.

25. (B) Using the Maxwell relation $(\partial S/\partial V)_T = (\partial P/\partial T)_V$: $(\partial U/\partial V)_T = T(\partial P/\partial T)_V - P = nRT/(V - nb) - P = an^2/V^2$. (It is 0 for an ideal gas.)

26. (B) The entropy of a photon gas is $S = (4/3)aVT^3$, so an adiabatic process keeps VT^3 constant. With $V \to 8V$, $T^3 \to T^3/8$, i.e. $T \to T/2$.

27. (D) $\omega_0 = 1/\sqrt{(LC)} = 1/\sqrt{(10^{-2}\times 10^{-6})} = 10^4$ rad/s. $Q = \omega_0 L/R = (10^4 \times 10^{-2})/10 = 10$. The bandwidth is $R/L = 10^3$ rad/s $= \omega_0/Q$.

28. (B) +45 = 00101101. Invert the bits: 11010010, then add 1: 11010011. (10101101 is the sign-magnitude form and 11010010 the one's complement.)

29. (C) Close in the upper half plane; the double pole at $z = i$ has residue $d/dz[(z + i)^{-2}]$ at $z = i = -2/(2i)^3 = 1/(4i)$. So the integral is $2\pi i \times 1/(4i) = \pi/2$.

30. (A) Write the matrix as $2I + T$ with $T = [[0, 1, 0], [1, 0, 1], [0, 1, 0]]$. T has characteristic polynomial $-\lambda^3 + 2\lambda$, so its eigenvalues are $0, \pm\sqrt{2}$. Hence the eigenvalues are 2 and $2 \pm \sqrt{2}$ (trace check: 6).

Part C: 3-mark numerical questions (+3, no negative)

31. (15) Answer: 15. Any pair of levels among $n = 1, \ldots, 6$ gives a line, so the number is ${}^6C_2 = 6 \times 5/2 = 15$.

32. (50) Answer: 50. After each bounce the speed is multiplied by e, so the rebound height is multiplied by $e^2 = 1/4$. Distance $= h + 2h(e^2 + e^4 + \ldots) = h(1 + e^2)/(1 - e^2) = 30 \times 1.25/0.75 = 50$ m.

33. (4) Answer: 4. $E^2 = p^2c^2 + m^2c^4$, so $pc = \sqrt{(25 - 9)} = 4$ GeV, i.e. $p = 4$ GeV/c (and $v = pc^2/E = 0.8c$).

34. (5) Answer: 5. $COP = T_c/(T_h - T_c) = 250/(300 - 250) = 5$.

35. (2) Answer: 2. Both poles $z = 0$ and $z = 1$ lie inside C. $Res(z = 0) = (0 + 1)/(0 - 1) = -1$, $Res(z = 1) = (1 + 1)/1 = 2$. The contour integral is $2\pi i(-1 + 2) = 2\pi i$, and dividing by πi gives 2.

36. (112) Answer: 112. J has rank 1 with eigenvalues 5 (eigenvector $(1, \ldots, 1)$) and 0 (four times). So $J + 2I$ has eigenvalues 7, 2, 2, 2, 2 and determinant $7 \times 2^4 = 112$.

37. (10) Answer: 10. $E = (n_x + n_y + n_z + 3/2)\hbar\omega$, so $n_x + n_y + n_z = 3$. The number of non-negative integer solutions is $(N + 1)(N + 2)/2$ with $N = 3$, i.e. 10.

38. (19) Answer: 19. Single-particle energies are n^2E_1. By the Pauli principle each level holds two electrons (spin up and down): $2 \times 1 + 2 \times 4 + 1 \times 9 = 19$, so $E = 19E_1$.

39. (–4) Answer: –4. $V_{out} = -R_f(V_1/R_1 + V_2/R_2) = -20\ k\Omega \times (1/10\ k\Omega + 0.5/5\ k\Omega) = -(2 + 2) = -4$ V.

40. (3) Answer: 3. The grating spacing is $d = 1$ cm$/5000 = 2\ \mu$m. The condition $d \sin\theta = n\lambda$ with $\sin\theta \le 1$ gives $n \le d/\lambda = 2/0.6 = 3.33$, so the highest order is 3.